

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

Summer Examinations, 2012/2013

Exam Code(s)	4IF
Exam(s)	4th Year Examination in BSc in IT
Module Code(s)	CT421
Module(s)	Artificial Intelligence
Repeat Paper	
External Examiner(s)	Professor M. O'Boyle
Internal Examiner(s)	*Dr M Madden *Dr Conn Mulvihill *Dr. F. S. Smith

Instructions: Attempt 2 questions from Section A, 1 from Section B and 1 from Section C.

Duration	<u>3 hours</u>
No. of Pages	<u>4</u>
Department(s)	<u>Information Technology</u>

Section A

Answer 2 questions from this section.

1)

- a) Write the following Prolog predicates:
- i) `double(List, Doubled)`. Where List is a list of integers and Doubled is the same list except all of its elements have been doubled.
(5 marks)
 - ii) `makeset(List, Set)`. Where List is a list of elements and Set is the same list but with all duplicates removed.
(11 marks)
- b) Explain the differences between Prolog and other languages like 'C'. Illustrate your explanation with examples.
(9 marks)

2)

- a) Write a predicate 'length' that takes two arguments. The predicate should return true if the 2nd argument is the length of the 1st argument.
(12 marks)
- b) Write a predicate 'between' that takes 3 arguments. The predicate should return true if the value of the 3rd argument lies between the values of the first and second arguments. For example:
- ?- `between(5,11,7)`. Evaluates to true
 - ?- `between(4,17,25)`. Evaluates to false
 - ?- `between(16,8,12)`. Evaluates to true
- (13 marks)

3)

- a) What are the differences between conventional 'crisp' logic and fuzzy logic. Illustrate your discussion with examples.
(9 marks)
- b) Give examples of situations where forward chaining and backward chaining would be suitable.
(7 marks)
- c) In terms of complexity, what are the differences between the following AI searches?
- i) Depth first search
 - ii) Breadth first search
 - iii) Depth first search with iterative deepening
- (9 marks)

Section B

Answer 1 question from this section.

4)

- a) Describe in detail how the ID3 algorithm operates to induce a decision tree from examples, including details of the Information Gain metric. (8 marks)
- b) One characteristic of decision trees is that they are potentially *unstable*. Explain what this means and how it arises. (2 marks)
- a) Discuss good experimental practice for comparing the performance of different classification algorithms for a specific task. As part of your answer, explain what training, testing and validation datasets are. (5 marks)
- b) A zoologist is investigating the use of the k-Nearest Neighbours algorithm to classify fish. She is aware that there are different ways of measuring “nearness”, but does not know which to use. Provide a description of at least four such measures, and formulate a set of guidelines that could be used to select which of these metrics to consider for a given application. (10 marks)

5)

- a) Describe the “kernel trick” as used in non-linear Support Vector Machines. (6 marks)
- b) Explain what both **conditional** independence and **absolute** independence are. Provide an example of each that illustrates the difference between them. How are each of these represented in a Bayesian network? (5 marks)
- c) Provide formulae for computing the probability of two events that are:
(i) independent; (ii) conditionally independent. (4 marks)
- d) Teagasc, the agricultural research authority, has asked you to assist them in pre-screening land that may be used to grow corn, a non-native crop. The probability of it growing successfully depends on whether or not the soil is alkaline, the level of rainfall (high, average or low) and the exposure to sun (sunny, normal, shaded). Explain how you would use a Bayesian algorithm to tackle this, including a description of the calculations required, the assumptions made and the probabilities that would be required for your model. (10 marks)

Section C

Answer 1 question from this section.

6)

- a) What is your understanding of the term 'intelligent agent'?
(5 marks)
- b) Consider a timetabling task involving the selection of on-the-hour slots on a twelve-hour day timetable running from 8AM to 8PM, Monday to Friday. Sketch how an agent could use this grid to pass simple steganographic information regarding a proposed day and time for a meeting.
Outline how two agents could also use this grid to establish a half-duplex channel for a fuller steganographic bitstream exchange.
(10 marks)
- c) Watson, the IBM system that competed in the game show 'Jeopardy!', is being deployed in cancer treatment and health insurance. Is Watson suitable for other domains as well in your view? Justify your answer.
(10 marks)

7)

- a) In the context of genetic algorithms, explain the term 'fitness function'.
(5 marks)
- b) Consider a genetic algorithm that is built for the travelling salesman problem. With a positive integer representation for cities, discuss any one issue in connection with this representation that may arise in mutation and crossover. You may, for explanatory purposes, assume that all the cities are on the circumference of a circle, and that there are exactly ten cities.
(10 marks)
- c) Consider a simple stack machine. Sketch how an evolutionary programming approach could be used to evolve programs for this type of architecture. For example, if you wish to compute a cube, the evolved program might be DUP DUP MUL MUL, where DUP duplicates the top of the stack and MUL multiplies the top two elements. You may employ your own instruction set.
(10 marks)